PATENT SPECIFICATION

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(54) METHOD OF MANUFACTURING ROLLED PRODUCTS FROM POWDERY MATERIALS, AND SHAPED ROLLS FOR CARRYING SAID METHOD INTO EFFECT

(71) We, INSTITUT PROBLEM MATERIALOVEDENIA AKADEMII NAUK UKRAINSKOI SSR, of 3, ulitsa Krzhizhanovskogo, Kiev, Union of Soviet Socialist Republics, a Body Corporate organized and existing under the Laws of the Union of Soviet Socialist Republics, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates generally to a method of manufacturing products from powdered materials and, more specifically, to a method of manufacturing such a product by rolling under pressure and to shaped rolls useful for carrying out this method.

It is well known to manufacture products from powdered materials by feeding and compacting the powder between a pair of co-operating rolls. The rolls used in this method have a generally cylindrical shape and a plain working surface; this method, however, fails to produce a rolled product which is adequately compact throughout its width, results in higher wastage and involves additional operations in order to crop the inadequately compacted edges of the product. Generally similar problems are encountered in the manufacture of profiled or shaped rolled products using profiled rolls to roll cast or forged poreless products.

It is an object of the present invention so to modify the rolling technique and the design of the rolls as to provide a method of manufacturing rolled products from powdered materials and shaped rolls for carrying out this method which would ensure the manufacture of a rolled product equally compact across its entire width, reduce the number of additional operations in the manufacturing process and make it possible to obtain shaped rolled products from powdered materials.

Thus, the present invention consists in apparatus for manufacturing a rolled product from a powdered material and comprising: a pair of co-operating rolls and optionally a mandrel located between the rolls, one of said rolls having a groove and the other having a matching projection to define therebetween the cross-sectional shape and the thickness of the product or, if a mandrel is provided, both rolls having matching grooves to define with the mandrel the cross-sectional shape and the thickness of the product, in which each roll has a pair of collars, one on each side of its groove or projection, so that each collar on one roll is opposed to a collar on the other roll and defines therebetween a cavity which, when said apparatus is used, is filled with said powdered material, the powdered material in the cavity shaping and exerting a lateral force on the edge of said product in the course of rolling, the thickness of said cavity (measured radially along a line perpendicular to the axes of the rolls being from 0.1 to 0.9 times the average thickness of said product and the width of said cavity (measured along a line parallel to and in the same plane as the axes of the two rolls) being from 0.2 to 3 times said average thickness.

The invention further consists in a method of manufacturing a rolled product, in which a powdered material is fed, over a width greater than the cross-section of said rolled product, and compressed between a pair of co-operating rolls and optionally around a mandrel located between the rolls, one of said rolls having a groove and the other having a matching projection to define therebetween the cross-sectional shape and the thickness of the product or, if a mandrel is used, both rolls having match-

ing grooves to define with the mandrel the cross-sectional shap and th thickness of th product, ach roll having a pair of collars, one on ach side of its groove or projection, so that each collar on one roll is opposed to a collar on the other roll and defines th rebetween a cavity filled with said powdered mat rial, the powd red material in the cavity shaping and exerting a lateral force on the edge of said product in the course of rolling, the thickness of said cavity (measured radially along a line perpendicular to the axes of the rolls) being from 0.1 to 0.9 times the average thickness of said product and the width of said cavity (measured along a line parallel to and in the same plane as the axes of the two rolls) being from 0.2 to 3 times said average thickness.

By varying the relationship between the thickness and the width of the cavity, one can alter the lateral forces effective on various sections of the shaped rolled product, thereby ensuring that uniform compacting of the powder may be obtained.

We prefer that the thickness of the cavity should be from 0.5 to 0.2 times the average thickness of the rolled product and that the width of the cavity should be from 1 to 2 times said average thickness. With these relationships between the thicknesses and the width of the cavity defined between the collars, a more adequate and uniform compacting of the powder being rolled may be obtained.

By means of the present invention, a rolled product which is equally compact across its entire width may be obtained: furthermore, it is possible to cut down production waste and the method and apparatus of the invention may be used to produce a variety of shaped rolled products from powders which have not been obtainable before by similar methods (e.g. solid-drawn porous pipes, sleeves, bushes, filters and sandwich-type bi-metal stock).

The powdered material is preferably a powdered metal or alloy or a metallic compound; but may be a mixture of a metallic powder with a non-metallic powder.

Forces of up to 15 tons per square centimetre are normally used for rolling a product. The rolling generally takes place at about room temperature (20° C) or may take place at a temperature of from 0.5 to 0.8 times the absolute temperature of the melting point of the metal. For example, aluminium granules heated to a temperature of about 450° C may be compacted by means of the apparatus of the present invention to obtain almost poreless products having the desired shape.

The invention is further illustrated with reference to the accompanying drawings, in which:

Figure 1 is a sch matic illustration of a rolling mill for manufacturing rolled products from powdered materials;

Figure 2 is a plan view of a pair of shaped rolls for manufacturing rolled products from a powdery material, including a roll mandrel of rectangular cross-s ction;

Figur 3 illustrates rolls similar to those shown in Figure 2, except that the roll mandrel is of circular cross-section;

Figure 4 is an enlarged view of the section marked "1" of Figure 2;

Figure 5 is an enlarged view of the section marked "II" of Figure 3;

Figure 6 is a plan view of shaped rolls for manufacturing a rolled product of V-shaped cross-section from a powdered material;

Figure 7 is a view similar to that of Figure 6 in which the rolled product has a semi-circular cross-section;

Figure 8 is a plan view of a pair of shaped rolls for manufacturing a rolled product whose cross-section comprises a plurality of joined V-shapes from powdered materials;

Figure 9 is a view similar to that of Figure 8 for manufacturing a rolled product whose cross-section comprises a plurality of joined semi-circles; and

Figure 10 is a side view of a pair of shaped rollers for manufacturing a solid-drawn seamless pipe from a powdered material.

Figure 1 shows schematically a rolling mill for manufacturing a rolled product from a powdered material, comprising an electric motor 1 which transmits torque through reduction gear units 2 to a pinion stand 3, which distributes and converts the imparted torque into two opposite torques which are transmitted through spindles 4 to rolls 5.

The plane including the axes of rolls 5 may be arranged either horizontally or at a small angle (up to 30°) to the horizontal. Accordingly, the rolling of the powdered starting material is effected either vertically or at an angle. Powder is fed from a hopper (not shown in Figure 1) to the rolls by its own weight across the feed width A (Figure 2), which is in excess of the actual width B of the product 6 being rolled.

Figure 2 illustrates a pair of rolls 7 for rolling solid-drawn seamless pipes 6 of rectangular cross-section. The shape and size of the external grooves 8 of the roll passes correspond to the external dimensions of the pipe 6, whereas the shape and size of a roll mandrel 9 corresponding to the internal dimensions and shape of the pipe bore. The grooves 8 are restricted by roll collars 10 and the powder is prevented from spilling from the hopper by fixed cheeks 11 attached to the hopper and each contacting one edge of the rolls 7 in the rolling zone to define a space which is filled with powder.

Figur 3 illustrates a pair of rolls 12 having

a different shape; in this case, the rolls are for manufacturing a solid-drawn seamless pipe 13 of circular cross-section.

The shape and size of grooves 14 of th roll pass s corr spond to the external dimensions of pipe 13, wh reas the shape and siz of roll mandr 115 correspond to th shape and diamet r of the pipe bore. The grooves 14 are restricted by collars 16.

The rolls 7 and 12 are bounded on each side by roll collars 10 and 16, respectively (Figures 2, 3, 4 and 5). Each pair of collars 10 and 16 defines a cavity 17 and 18, respectively. Each cavity 17 and 18 communicates with a thicker cavity 31 and 32, respectively. As appears from Figures 2, 3, 4 and 5 each roll has a portion on the side of each collar remote from the product being rolled and opposed to a corresponding portion on the other roll, the said portions defining thicker cavities 31 and 32 which when the apparatus is used are filled with powdered metal. The thicknesses of cavities 17 and 18 are M and N and the thicknesses H_1 and H_2 of cavities 31 and 32 are the sum of (C_1+M+C_2) and (E_1+N+E_2), respectively. The thicknesses M and N are from 0.1 to 0.9 times the average thicknesses H and J of the rolled product. The width of the cavities 17 and 18 F and G are from 0.2 to 3 times the average thicknesses H and J. We prefer that the thicknesses H_1 and H_2 of the thicker cavities should be substantially equal to the average thicknesses of the product.

During the rolling, lateral forces develop in cavities 17 and 18 towards the product. These forces cause compacting of the ends of the product.

Figures 6 and 7 illustrate embodiments of shaped rolls 19 and 20 for manufacturing single-section V-shaped and semi-circular products from powdered material. Roll collars 21 and 22 are similar in function to collars 10 and 16 shown in Figures 2, 3, 4 and 5. The rolls 19 and 20 have such a design of their roll pass that the angle φ is at least 15°, since at smaller angles rolling of powdered materials is impracticable.

Figures 8 and 9 illustrate embodiments of shaped rolls 23 and 24 for manufacturing multi-sectional V-shaped and semi-circular products in a manner similar to that illustrated in Figures 6 and 7. A roll pass design for producing multi-sectional products may also be rectangular, round, oval, diamond or other suitable shapes.

As in the case of rolling with plain cylindrical rolls, the average thicknesses H and J of the product (i.e. the average roll pass height) is equal to approximately one hundredth of the overall roll diameter. At the same time, the total heights K and L (Figures 6 and 7) of the roll passes or the diameter D (Figure 3) of the roll passes in rolling a seamless pipe 13 considerably exc ed 1% of the roll diameter, which mak s it possibl to xtend the range of pipes produced.

The grooves in the rolls are so shaped that the centre line of the groove coincides with the centre line of the rolls.

The length of th solid-drawn pipes produced d pends upon the length of th roll mandrel 9 or 15. To prevent the mandrel from being stuck to the pipe 6 or 13, the mandrels are ground and hardened to a high hardness number and, before rolling, are lubricated with oil or glycerol.

Rolling of equally compact shaped products is effected as follows:

When rolling single-section or multi-section shaped products, the powdered material is continuously fed downwards from a hopper to the rotating rolls so that the width over which the material is fed is in excess of the width of the product being rolled; the finished product comes off the rolls downwards.

When rolling solid-drawn pipes, in order to obtain an equally compact pipe throughout its cross-section, a roll mandrel 23 (Figure 10) is provided with an elastic (e.g. rubber) ring 24 having a thickness approximately the same as the thickness H or J of the pipe being produced. The roll mandrel 23 with the elastic ring 24 slipped over it is fed through locating rolls 25, whereupon the rolls are stopped and powdered material is then fed from a hopper 26 into the space 27 between the rolls and the mandrel over a width greater than the outer diameter of the pipe being rolled. To ensure that the mandrel 23 is perpendicular to the centreline 28 of the rolls 25, the mandrel 23 is guided to the rolls through a centering ring 29. After centering the mandrel, pipes are then rolled from the powdered material. The rate of rolling may vary from 1 to 20 metres per minute, the powder being fed under its own weight. Once the finished pipe has been produced, the mandrel is extracted from the pipe.

WHAT WE CLAIM IS:—

1. Apparatus for manufacturing a rolled product from a powdered material and comprising: a pair of co-operating rolls and optionally a mandrel located between the rolls, one of said rolls having a groove and the other having a matching projection to define therebetween the cross-sectional shape and the thickness of the product or, if a mandrel is provided, both rolls having matching grooves to define with the mandrel the cross-sectional shape and the thickness of the product, in which each roll has a pair of collars, one on each side of its groove or projection, so that each collar on one roll is opposed to a collar on the other roll and defines therebetween a cavity which, when said apparatus is used, is filled

with said powdered mat rial, the powdered material in the cavity shaping and xerting a lateral forc on the dge of said product in the course of rolling, the thickness of said cavity (m asured radially along a line perpendicular to th axes of th rolls) being from 0.1 to 0.9 times the average thickness of said product and the width of said cavity (measured along a line parallel to and in the same plane as the axes of the two rolls) being from 0.2 to 3 times said average thickness.

2. Apparatus according to claim 1, in which the thickness of said cavity is from 0.5 to 0.2 times said average thickness.

3. Apparatus according to claim 1 or claim 2, in which the width of said cavity is from 1 to 2 times said average thickness.

4. Apparatus according to any preceding claim, wherein each roll has a portion on the side of each collar remote from the product being rolled and opposed to a corresponding portion on the other roll, said portions defining therebetween a thicker cavity which communicates with said cavity and when said apparatus is used is filled with powdered material.

5. Apparatus according to claim 4, wherein the thickness of said thicker cavity is substantially equal to the average thickness of the product.

6. Apparatus according to claim 1, substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

7. A method of manufacturing a rolled product, in which a powdered material is fed, over a width greater than the cross-section of said rolled product, and compressed between a pair of co-operating rolls and optionally around a mandrel located between the rolls, one of said rolls having a groove and the other having a matching projection to define therebetween the cross-sectional shape and the thickness of the product or, if a mandrel is used, both rolls having matching grooves to define with the mandrel the cross-sectional shape and the thickness of the product, each roll having a pair of collars, one on each side of its groove or projection, so that each collar on one roll is opposed to a collar on the other roll and defines therebetween a cavity filled with said powdered material, the powdered material in the cavity shaping and exerting a lateral force on the edge of said product in the course of rolling, the thickness of said cavity (measured radially along a line perpendicular to the axes of the rolls) being from 0.1 to 0.9 times th averag thickness of said product and the width of said cavity (measured along a line parall l to and in the sam plane as the axes of the two rolls) being from 0.2 to 3 times said averag thickness.

8. A method according to claim 7, in which the thickn ss of said cavity is from 0.5 to 0.2 times said average thickness.

9. A method according to claim 7 or claim 8, in which the width of said cavity is from 1 to 2 times said average thickness.

10. A method according to any one of claims 7 to 9 in which each roll has a portion on the side of each collar remote from the product being rolled and opposed to a corresponding portion on the other roll, said portions defining therebetween a thicker cavity which communicates with said narrow cavity and is filled with powdered material.

11. A method according to claim 10, wherein the thickness of said thicker cavity is substantially equal to the thickness of the product.

12. A method according to any one of claims 7 to 11, in which said powdered material is a metal or an alloy.

13. A method according to any one of claims 7 to 12, in which said powdered material is a mixture of a metal and a non-metal.

14. A method according to claim 12, in which said powdered material comprises aluminium.

15. A method according to claim 14, in which said aluminium is heated to a temperature of about 450° C.

16. A method according to any one of claims 7 to 13, effected at room temperature.

17. A method according to any one of claims 7 to 13, effected at a temperature of from 0.5 to 0.8 times the absolute melting point of said powdered material.

18. A method according to any one of claims 7 to 17, in which the force on said powdered material during rolling is up to 15 tons per square centimetre.

19. A method according to claim 7, substantially as hereinbefore described with reference to the accompanying drawings.

20. A rolled product when produced by a method according to any one of claims 7 to 19.

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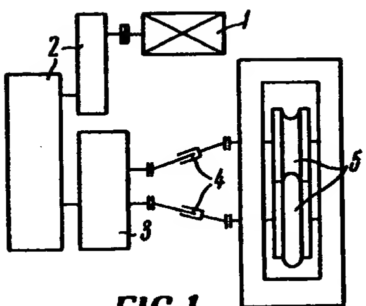

FIG. 1

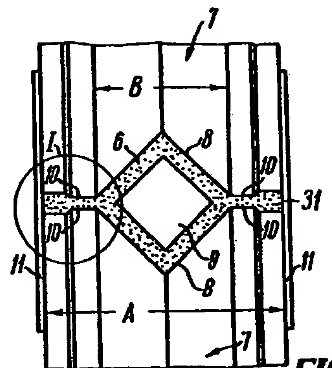

FIG. 2

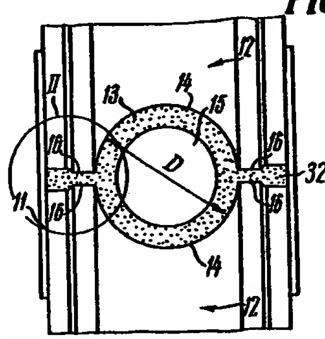

FIG. 3

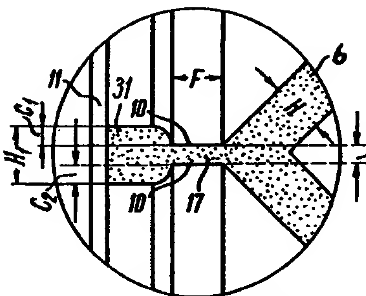

FIG. 4

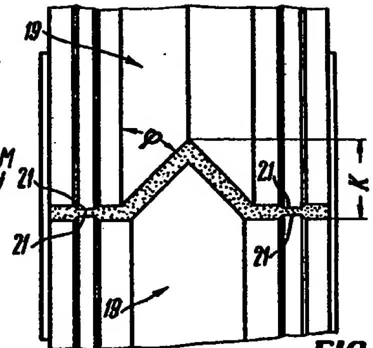

FIG. 6

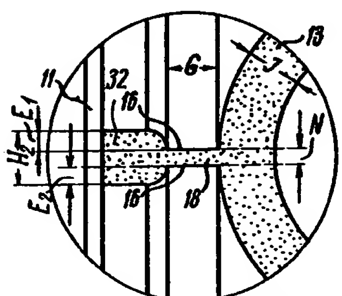

FIG. 5

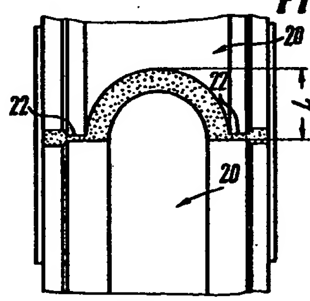

FIG. 7

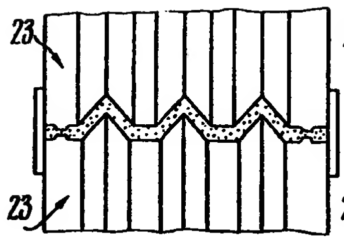

FIG. 8

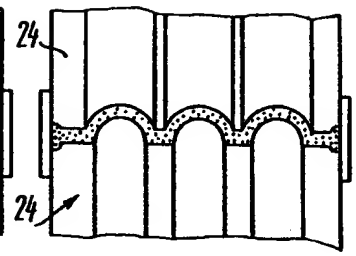

FIG. 9

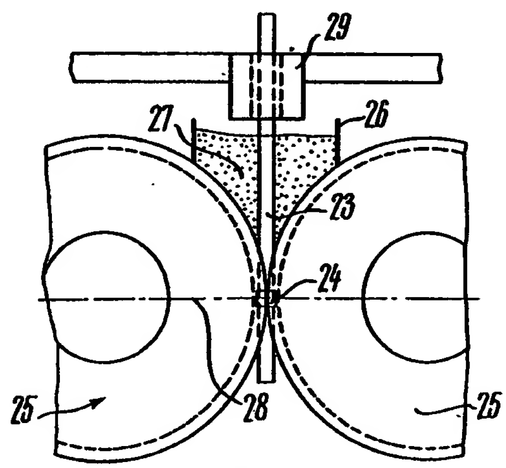

FIG. 10